Science Center
Rockwell International
1049 Camino Dos Rios
P.O. Box 1085
Thousand Oaks, California 91358
(805) 373-4545

Rockwell International

(2)

January 8, 1992

In reply refer to G.O. 71033

Office of Naval Research
800 North Quincy Street
Arlington, VA 22217-5000

Attention: Dr. Wallace A. Smith

Subject: Quarterly R&D Status Report No. 5
"Electrodeposition of High Temperature Superconductors"
For period 10/01/91 through 12/31/91
Contract No. N00014-90-C-0225
SC71033.QRDSR

Enclosed is subject report.

ROCKWELL INTERNATIONAL CORPORATION
Science Center

D.M. Tench
Principal Investigator

cs: Scientific Officer - Materials Division
Office of Naval Research
800 North Quincy Street
Arlington, VA 22217-400
Attn: Wallace Smith ..... 2 copies
Ref: contract No. N00014-90-C-0225

Director, Advanced Research Projects Agency
3701 North Fairfax Drive
Arlington, VA 22203-1714
Attn: DSO/Frank Patten .....1 copy
Scientific Officer .....3 copies
Adm. Contracting Officer ..... 1 copy

Director, Naval Research Laboratory
Attn: Code 2627
Washington, D.C. 20375 ..... 1 copy

Defense Technical Information Center
Bldg. 5, Cameron Station
Alexandria, VA 22034-6145 ... 2 copies

Strategic Analysis
4001 N. Fairfax Drive, No. 765
Arlington, VA 22203
Attn: Mark Davis .....1 copy

08 January 1992 In reply refer to G.O. 71033

Office of Naval Research
800 North Quincy Street
Arlington, VA 22217-5000

Attention: Dr. Wallace A. Smith

Subject: Quarterly R&D Status Report No. 5
"Electrodeposition of High Temperature Superconductors"
For period 10/01/91 through 12/31/91
Contract No. N00014-90-C-0225
SC71033.QRDSR

PROGRAM SUMMARY

The overall objective of this project is to develop a process for direct electrodeposition of Y-Ba-Cu superconducting oxides from a molten salt at relatively low temperatures (300-550°C). The approach entails establishing a sequence of electrochemical steps for the layered deposition of Y, Ba and Cu oxide species from a eutectic Na-K nitrate melt.

PROGRAM STATUS

The background data needed to define appropriate procedures/voltage sequences for electrodeposition of Y-Ba-Cu HTSC oxides have been obtained. Electrodeposition of CuO has been investigated in detail and shown to be insensitive to temperature (at least to 400°C). All three metals have been demonstrated to electrodeposit from the nitrate melt and the current-voltage characteristics for the deposition/dissolution processes have been established. Both Cu and Y have been shown to electrodissolve in the melt and to deposit as the oxides (CuO and Y_2O_3). Deposition of Y oxide on Cu oxide electrodes results in a uniform film composition over a 0.4 μm thicknesses, indicating that formation of mixed metal oxide compounds occurs. Since direct oxide electrodeposition occurs (at least for Cu and Y) in the nitrate melt, this system is ideally suited for deposition of HTSC materials. Direct metal oxide deposition presumably involves reduction of nitrate complexed with the metal cation and therefore should be a general phenomenon applicable to preparation of a wide range of mixed metal oxides.

ACCOMPLISHMENTS

An invention disclosure entitled "Method for Metal Oxide Deposition" by M. W. Kendig and D. M. Tench was submitted to the Rockwell Science Center Patent Department; a copy is attached. Electrodeposition from nitrate melts is claimed as a general method of preparing oxides that could have wide applications.

No experimental progress was made during this reporting period since the incremental funding needed to continue this work has not been received.

PROBLEM AREAS

Incremental funding is needed to continue this work.

GOALS FOR NEXT REPORTING PERIOD

Future work will focus on developing and evaluating promising schemes for electrodeposition of Y-Ba-Cu HTSC materials. Initial studies will be directed toward evaluating the molten salt electrochemical equivalent of molecular beam epitaxy. In this case, the electrode voltage is maintained just positive of that required for Ba oxide deposition, and monolayer amounts of Cu and Y are injected (by electrodissolution of individual metal electrodes) and electrodeposited in sequence. A cell of very small volume is used to ensure that complete deposition of the injected metal occurs in a short time. Incorporation of Ba oxide layers should occur in proper sequence by underpotential compound formation. This simple straightforward approach will be investigated thoroughly before more complicated deposition schemes are considered.

Rockwell International Science Center

D. M. Tench

D. M. Tench
Principal Investigator

Docket No. 91SC106

INNOVATION DISCLOSURE

1. **Innovator(s)**

Name	Department No. & Mail Code	Comnet Telephone	Supervisor
Martin W. Kendig	D-205, 083-A12	253-4241	D. M. Tench
D. Morgan Tench	D-205, 083-A12	253-4509	J. P. Rode

2. **Title:** Method for Metal Oxide Deposition

3. **Short statement of problem solved:** Metal oxides are of tremendous technological importrance as corrosion protective coatings, catalysts, ferroelectric materials, high temperature superconductors, battery active materials, etc., but are difficult to deposit/fabricate in the anhydrous forms usually needed.

4. **Short statement of your solution:** We have discovered that dense metal oxide films can be deposited directly on conducting substrates by electrolysis of nitrate melts containing the ions of the corresponding metal, e.g., Cu(II) or Y(III). Such electrodeposits can readily be applied to odd shaped parts and should not exhibit the porosity and cracking associated with dehydration/condensation of analogous films electrodeposited from aqueous solutions or produced by the sol gel process. We believe that electrodeposition of metal oxides (rather than free metals) is a general, and previously unknown, characteristic of nitrate melts which can be used to prepare a wide variety of single and mixed metal oxides.

5. **Status of innovation:** _ Idea _ In design X Under development X Feasibility shown
Other _____

6. **Has any work on the innovation been charged to a Government contract?** __ No X Yes
If so, G.O. No. 71033 If not, IR&D No. or other charge _____

7. **Product or program in which innovation will be used:** Variety of potential applications, e.g., high temperature superconductors, ferroelectrics, and corrosion protective coatings

8. **Has anyone disclosed or does anyone plan to disclose your innovation outside the Company?**
_ No X Yes If so, when and how: 15 July 91, Molten Salt Conf., Paris, France

9. **Has anyone proposed or does anyone plan to propose a product or program to a customer which includes your innovation?**
_ No X Yes If so, when and how: Follow-on to G.O. No. 71033

10. **Innovator signature(s):** Martin W. Kendig **Date** 5 Dec 91
D. Morgan Tench **Date** 5 Dec 91